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By

R. S. Kaushal
Formerly UGC Research Professor, Department of Physics & Astrophysics, University of Delhi, Delhi -110007, and AD-48C, Shalimar Bagh, Delhi-110088, India
E-mail: kaushal.rs@gmail.com

Research Project by University of Delhi, Delhi -110007

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Message from the Desk of Editor

It gives me immense pleasure to welcome all to explore/publish/ comment in/on our journal, The International Journal of Indian Psychology (IJIP). There are a lot of challenges which the growing psychological face in the realms of basic necessities in life. Psychological thoughts can play a very distinct role in bringing about this change. One of the key objectives of research should be its usability and application. This journal attempts to document and spark a debate on the research focused on psychological research and ideas in context of emerging geographies. The sectors could range from psychological education and improvement, mental health, environmental issues and solution, health care and medicine and psychological related areas. The key focus would however be the emerging sectors and research which discusses application and usability in social or health context.

We intended to publish case reports, review articles, with main focus on original research articles. Over objective is to reach all the psychological practitioners, who have knowledge and interest but have no time to record the interesting cases, research activities and new innovative procedures which helps us in updating our knowledge and improving our treatment.

Finally, I would like to thank RED'SHINE International Publications, for this keepsake, and my editorial team, technical team, designing team, promoting team, indexing team, authors and well wishers, who are promoting this journal. With these words, I conclude and promise that the standards policies will be maintained. We hope that the research featured here sets up many new milestones. I look forward to make this endeavour very meaningful.

Prof. Suresh Makvana, PhD[1]
Editor in Chief,
HOD & Professor, Dept. of Psychology,
Sardar Patel University,
Vallabh Vidyanagar,
Gujarat, India

[1] ksmnortol@gmail.com

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ABSTRACT

Physics concepts and theories when analogously used in soft disciplines like psychology, sociology and economics, give rise to an altogether new dimension of study and development of the corresponding subject since physics itself offers an exact, analytical and quantifiable methodology for this purpose. From this point of view the century old subject of psychophysics is sought to be revisited. This article emphasizes a unifying approach to study all the three seemingly different disciplines of psychophysics (pertaining to an individual), sociophysics (pertaining to a collection of individuals) and econophysics (pertaining to an important utility for individuals and also for their collections) in a common framework, perhaps for the first time. The frame work basically generates out of the modeling of an individual (cf. patomic model of human Being) as per Vedic Science. It is argued that such newly developed psychophysics, when applied to sociology and economics, will not only offer a better understanding of the role of 'human component' in these disciplines, but also provide new dimensions for research. Some glimpses into this effect are given here with reference to the prospect theory of Daniel Kahneman in behavioral economics. In the same vein, a need to explore disciplines like psychochemistry, sociochemistry and econochemistry with reference to the role of 'human component' is emphasized.

***Key words**:*
Psychophysics, complex systems, patomic model, sociophysics, econophysics

CHAPTER 1
INTRODUCTION

In the history of physical sciences, there was a time when mathematics was considered as the 'queen' of natural sciences since every branch of physics, chemistry and even of biology wanted to marry it. Over a period of time, however, the scenario has changed. The laws of mathematics are not only in use in the realms of almost all soft disciplines including humanities and social sciences but now physics too seems to take the earlier place of mathematics in the sense that several soft disciplines are standing in the queue to marry physics. Why should it not be? After all the nature of physics laws, their universality and over and above them all the methodology used therein through modeling games are a few salient features of physics which impress the experts of other fields to marry it. This sponsors the fact that if mathematics offers the language in which Nature expresses Herself better, then physics does carry the theme to be conveyed (expressed) through that language.

Now the question arises whether these marriages–first of mathematics with other disciplines and now of physics with soft disciplines, are going to be genetically acceptable and stable or else they just are the marriages of convenience to fulfill the timely need. The present article is an attempt to look for an answer to such questions more in a philosophical spirit.

Before proceeding further it is worthwhile to understand the nature of knowledge-content covered in the subjects of mathematics and physics, and also the way in which this knowledge is used in other disciplines mostly through analogies, similarities and parallelism either at the level of concept, sequence of concepts, model or the phenomenon as a whole.

1.1 The nature of knowledge-content in mathematics and physics

In philosophical terms, the nature of knowledge-content concerning the 'world' and the 'world-order' in general is considered of two types, namely the practical or space-time mediated (knitted) knowledge (dealing mostly with day-to-day life or with the perceptible physical world) and the theoretical knowledge (dealing mostly with certain logical and consistent concepts of mental world and the same could be beyond space and time). No doubt, these categories of knowledge-content are complementary to each other as far as the 'cause and effect' principle is concerned but the fact is that the necessity of both and also that of corresponding expertise is always felt in society since time immemorial. At times, it has also been felt that only a few principles framed cleverly at the theoretical level just suffice for a variety of applications in the outer physical world. This phenomenon gives rise to the processes of abstraction and proliferation of knowledge. In fact, as and when it becomes possible for an expert to put the available knowledge in a nut-shell (conceptually or mathematically or otherwise) then this is termed as the 'process of abstraction'. On the other hand, certain beautifully and cleverly designed concepts, principles or models of the mental world are found to have variety of applications in diverse fields in the outer physical world. This is termed as the 'process of proliferation' of knowledge. In this spirit, the subjects of mathematics and physics have been growing as the histories of these subjects reveal. On this basis, note that both mathematics and physics have two broad aspects of study, namely (i) pure, and (ii) applied.

It may be mentioned that the philosophy of natural sciences starts with the pure category of knowledge-content in the corresponding subject. Further, it has roots in the space time structure of Nature and accounts only for the partial truth in Nature. For the remaining truth in Nature, however, one has to rely on or tread into the domain of philosophy of behavioral or spiritual sciences. As a matter of fact, these are only the pure components of the knowledge-contents in both mathematics and physics that can conveniently find a place in the philosophy of human sciences and thereby help in the realization of complete truth in Nature.

Look at the constructs in pure mathematics. What a wonderful conceptualization has been done there over the years by great minds and that too just out of the blue! The type of abstraction pursued there in creating and defining the so-called abstract systems is amazing. In fact the entire gamut of mathematical concepts spread all over in different branches of applied mathematics can find their roots in these abstract systems. It is the question of putting only flesh and blood on the frames designed already or on the ones newly created as per need but in tune with the abstraction process. For example, these available frames starting with set, field, vector space, group, etc., continue to ring, topology and several others, along with equally abstract concepts of relations, operations, theorems, etc, between and among the elements of a system and also in their collections in different contexts and situations. It may be noted that not only the different branches of applied mathematics find roots in these abstract constructions but soft disciplines are also benefitted from these studies. For example, the concept of group has played a dominant role in several branches of physics, chemistry, biology and even of humanities and social sciences including finances. The latter do have roots in these constructions and are beneficiaries of these abstract concepts. Such development, once again forces one to believe in the inherent beauty of the language of mathematics.

Whatever picture is drawn above of pure mathematics, similar is the case with pure physics. Certain fundamental principles and basic laws developed in mechanics of different types more in an abstract way are responsible for giving birth to other but still basic laws on which stem the other branches of physics. For example, kinetic theory of gases, laws of thermodynamics, laws on which the four Maxwell's equations are based, laws of reflection and refractions including Huygen's principle etc. do form the basis of development of conventional disciplines of physics like heat, electricity and magnetism, optics etc. The latter class of laws, in fact, is derived by combining mechanics with the perception of the corresponding physical phenomenon. In some sense the subject of mechanics with all its varieties and field theoretic generalization plays an important role in the development of various branches of physics. It is this subject which basically accounts for the space time structure of Nature and the prevailing dynamism in it. Note that the world- or cosmic-order and its sustenance is better understood through 'dynamism' rather than through 'statism' as their change in Nature with time is eternal and bound to be there. We, however, refrain ourselves from going into further discussions on the philosophy of physics here and list below a broad classification of different disciplines in physics [1].

(A) *Mathematical disciplines*: Dealing basically with fundamental principles and methodology associated with space time structure of Nature and consisting of classical and quantum mechanics, statistical and stochastic mechanics, classical and quantum field theories.

(B) *Conceptual disciplines:* Dealing mostly with modeling game at micro, macro, mega and giga scales and consisting of condensed matter, molecular, atomic, nuclear, elementary particle and quark physics, astrophysics.

(C) *Conventional disciplines:* Developed over a period of years and centuries on the basis of human perception of Nature in day-to-day experiences and consisting of general properties of matter, heat, optics, electricity and magnetism, etc.

(D) *Engineering or disciplines of applied physics:* Leading to increasingly newer technologies and responsible for making human life comfortable and luxurious.

A few remarks about this classification of physics- disciplines are in order here:

(i) While category (A) suggests a working (mathematical/conceptual) framework for the categories (B), (C) and (D), the latter ones to some extent, appear as modeling games as far as the understanding of Nature is concerned.

(ii) Category (B) mostly deals with micro-physics and (C) mostly with macro-physics. Further, as one traces back from category (D) to (A) the abstraction in terms either of mathematical formulae or of concepts increases in the sense that in (D) it is all proliferation of basic knowledge of (A) – (C).

(iii) When all that in above point (ii) happens, note that knowledge content in category (A) does get a feedback for further improvement in basic laws. As an example, for a given conceptual setting, the category (A) suggests a variety of mathematical formulae (of course, phenomenon- dependent) which are readily applicable to the systems in (B) – (D). This happens with minor variations at the input- conceptual –level in (A) and with seemingly different major variations at the output levels of experimentation and subsequent applications in the practical life in categories (B) – (D).

(iv) It is worthwhile to highlight here a historical fact. It is a common practice with physicists to jump to newer disciplines without really understanding the older ones in totality. Further, this has happened not only with the disciplines in categories (B) – (D), which are prone to more frequent experimental tests, but also with the category (A). For example, without understanding the classical mechanics completely (with reference to non-centrality and anharmonicity of forces and integrability of systems, nonlinearity in general, etc.) for three hundred years and more (after Newton), quantum concepts were floated only about 100 years ago and subsequently quantum field theory grew up in the same vein. The same is also the case with the development of conceptual disciplines in category (B) (e.g., growth of particle physics without understanding the nucleus) and to some extent with the conventional disciplines in (C). As a matter of fact the degree of understanding of categories (B) and (C) turns out further one order less as compared to that of (A) since by and large the latter forms the basis of study for (B) – (D). Note that fundamental and challenging questions remain largely unanswered even today almost in each of these disciplines.

(v) Note that all throughout the development of disciplines of physics discussed in (A) – (D), the concept of analogy, in particular that of structure analogy, play an important role and we discuss the same in the next sub-section.

1.2 The role of structural analogy and its contents in the development of a discipline

Whether it is the process of abstraction or of proliferation of knowledge in either case the concepts of analogy (or its variants like parallelism, similarity, symmetry etc.) play a dominant role in the respective studies. Indeed a generalized concept of 'structural analogy' has been found (Ref.(1), Chapter 5) to accommodate all these variants of the more or less same philosophical concept including that of metaphor/simile of the grammar of a language. As a matter of fact, this concept has been prevailing equally in both soft (through literary beauty and philosophical interpretations) and hard (through logical concepts and mathematical constructs) disciplines. It may be further mentioned that the abstraction aspect of knowledge while have tendency to connect with the philosophy of the subject, the proliferation aspect, on the other hand, elaborates the applications of the subject in a down-to-earth style. For further details of these concepts we refer to our earlier work [1] and present here only a nut-shell summary of the proposed generalized concept of the so-called 'structural analogy', i.e., the analogy elaborated through its contents and sub-contents in a very general manner.

In the language of pure mathematics, the analogy can be considered as the mapping (or correspondence) of one set of objects to the other in the same or in different mental spaces and with certain features preserved during this process. The features which can be exploited are: (i) the elements of the set (the so-called 'objects'), (ii) the relations between and among elements or the internal correspondences among subsets of the set, (iii) mappings on the set as a whole (called 'rules of the game'). At the next stage, the characterization either of elements of the set or of mappings on it possibly could be on the basis of their physical, mathematical or philosophical contents. Further the comparing sets may appear at different scales or at the same scale in terms of space, time and/or their mental pictures. Schematically, the contents of structural analogy are displayed in Fig.1.

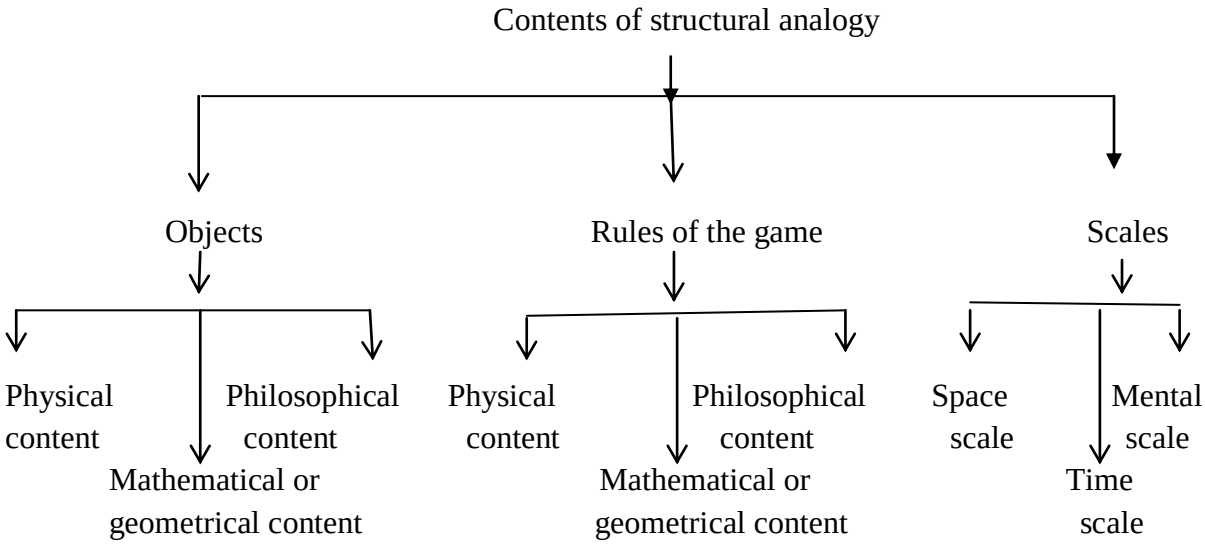

Fig. 1: *Schematic representation of contents of a structural analogy.*

For further elaboration of the contents listed in Fig.1 and their respective examples from both soft and hard disciplines, we refer to our earlier work [1]. Here, however, it is worthwhile to make a few pertinent remarks about these studies essentially in a philosophical spirit:

(i) Note that Fig.1 lists an ideal set of all possible elements to be compared in the two situations. Although it depends on the case, but the fact is that not all these items are generally available at a time for comparison. As a result, the comparison is often restricted only to a few items.

(ii) As far as the use of an analogy (cf. Fig.1) is concerned, one can define its order on the basis of the fineness/subtlety of the contents. In the lowest (first) order one can go for the comparison of objects, rules of the game and of scales, if at all they are involved. At the next stage, in the second-order, one can compare the physical, mathematical or geometrical and/or philosophical contents of the objects and the rules of the game along with their space, time and mental scales if they are involved.

(iii) Normally, analogies are used from the set of known elements to the set of unknown ones, or to explain and understand the unknown ones via known but the cases are equally popular when analogies are used from known to known situation or somewhat less popular are the cases from unknown to known and hardly any case from unknown to unknown (cf. Ref. (1), Chapter 5).

(iv) In fact it is the set of suppositions on the nature of correlations (rules of the game) among objects that bring them together for comparison as far as the explanation/description of the two situations is concerned. However, the analogy is considered to be the best if the number of suppositions (n) and the gap (g) between the explanation/description of the two situations are minimum. Thus, the quality of analogy (q) is inversely proportional to both n and g, viz.,

$$q \propto \frac{1}{ng} \quad \text{or} \quad q = \frac{K}{ng} \ , \tag{1}$$

where K, the constant of proportionality, is a measure of the merit (i.e., the level of development of his faculty of understanding of the individual user of analogy. (Faculty of understanding of an individual is a composite of dressed versions of faculties of emotion, decision and memory with his consciousness. For details see, Sect.3.1 (c) and Glossary of Words in Ref.(2)). If one goes with the three-world concept of Karl Popper (the world- one, which exists; the world-two, which is perceived, and the world-three, which is modeled by the theory) with reference to having a feel for the complete truth in Nature, then q is also the measure of the quality of a model used for the purpose.

Note that the points highlighted above in Sects. 1.1 and 1.2, will form the basis of discussion in future sections, which, in turn will help in exploring the sustainability of these newly emerging subjects in future. Since these newly emerging subjects basically form the examples of complex systems, therefore, in the next section we, briefly review the methodology used in the study of such systems in a very general manner. Sects. 3-5 are devoted respectively to analyze the contents of subjects of psychophysics, sociophysics and econophysics within these frameworks. Finally, the concluding remarks are made in Sect. 6.

1.3 Notations and abbreviations used in the Text

For ready reference, we list below the notations and abbreviations used in the Text:

b = Being (or *Jiva* or life principle), B = biological body, $\mathcal{C}$ = causal body, E = ego or self-conscience, EOLs = essences of life , FOUs = faculties of understanding , $\mathcal{G}$, = gross body, I = intellect, faculty of decision , M = mind, faculty of emotion, $\mathcal{M}$ = micro-body, mindset function, μ = meditation variable/parameter , SE = senses of perception and action, SO = soul or inner most existence, WO = worldly objects or outer world of objects.

CHAPTER 2
COMPLEXITY IN NATURE AND THE STUDY OF COMPLEX SYSTEMS

2.1 Hierarchy of complexities

When the question of understanding of the outer world in terms of its structural and working in totality by a common man arises, it all appears to him as very complex. Truly speaking, for a conscious person the complexity in Nature appears as inversely proportional to his level of understanding (or more precisely the level of development of his faculties of understanding [2]). Note that the level of understanding of a person is a measure of evolution of human race in general or of human intellect in particular. In other words, in philosophical terms, it is the ignorance of a person or of a group of persons that is responsible for giving the feeling of complexities in Nature at different space time points; otherwise for a 'man of perfection' i.e. for yogi category of persons (see, Glossary of Words in Ref.(2)), there is nothing like the complexity in Nature. He rather understands (and accordingly acts) all intricacies in Nature. For a common man (including a scientist who, as an individual, equipped with limited faculty of understanding and some experimental tools), however, there appears a hierarchy of complexities at different levels of study, space time scales, and environment. For example, complexities can arise at local, global and Universal levels and again with reference to both living and nonliving systems.

No doubt, at a certain scale a system may appear simple and understandable but as one proceeds towards its sub-structures and their working on one hand, or towards its macro and giga existences on the other, then the same system starts revealing more and more complexities in Nature for an observer. In such a situation it becomes a herculean task for a human mind to study the Nature in totality. In spite of all this, there exists a supernatural entity, which beautifully maintains the world, cosmos and their orders in a rather self-consistent manner. Perhaps, for this reason, man postulated 'God' long ago as the 'Super Power' or the 'Super Creator/designer' of things.

The study of creation (i.e., generation (G)), survival (i.e., organization (O)) and annihilation (i.e., destruction (D)) with reference to the life and matter in the Universe including the role of the so-conceived controller (or the sustainer of these processes), who is three in one, i.e, G+O+D=GOD) has been the choice of the best of human minds since time memorial. Modern science, while has progressed a lot on the front of matter and energy, somehow the front of life and death is not explored to the same extent in spite of the availability of best technologies today. Starting with the five cosmic elements, namely earth, water, air, fire and ether (which respectively are the representatives of five states of matter, namely solid, liquid, gas, plasmon and space) of Vedic science and about 120 elements of periodic table of modern science, note that the Nature is not yet understood completely even today. Whether it is the question of life in a Being or the matter in the Universe both these phenomenon pose equally complex problems as far as the understanding of dynamism in Nature is concerned. Simplified or idealized versions of these rather complex phenomena, do not, in fact, contribute more than 5% to the complete understanding and that too under highly simplifying assumptions made in the model or theory.

As a matter of fact, for a common man who has a limited faculty of understanding, the complexity in Nature appears rather natural but for a 'man of perfection' (who has developed his faculty of understanding to the highest degree which too is an idealized state) this apparent complexity will possibly be resolved into simplicity. As mentioned before, the appearing complexity in Nature for an individual is inversely proportional to the level of development of his faculties of understanding. However, scientists in general and physicists in particular, are also trying to understand only an idealized or simplified version of Nature. In this endeavor they have been rather successful but only in understanding the partial truth instead of the complete truth in it. This is mainly because they can only handle the simplicity in Nature better than the complexity in it in terms of their limited study tools including mathematical methods and experiments. Further, in view of limitations on one's faculty of understanding, it appears that the understanding of real truth in Nature will remain a far cry for him. Next we list some well known difficulties faced by a theoretical physicist as far as his understanding of complete truth in Nature is concerned.

2.2 Complex systems and their understanding

Note that for a physicist, the gases are ideal, the conductors are supper, surfaces are smooth, etc, but in reality it is not so. At the next stage of simplicity or ideality with regard to the exact solvability of the problem, one assumes that the forces are harmonic or act only in one dimension or are central in higher dimensions, involved dynamical equations are linear or are made linear using suitable assumptions/postulates in the theory, symmetries are assumed leading to conservation laws, if at all they are there, etc. Further, invariants (dynamical or otherwise) are designed to simplify the computation or to establish the integrability of the system under study. Over and above them all is the 'closed-ness' of the physical system that is taken as granted very often even if the system is highly sensitive to interactions with the environment.

In some sense it is not the fault of a physicist; these idealizations somehow create a unique situation to handle the problem rather exactly in terms of modeling and computation. While Nature likes these idealizations in some selective cases, in most other cases the natural phenomena remain rather unexplored in exact terms due to the underlying complexities at different levels. As soon as one thinks of departing from these simplicities or idealizations and thinks of accounting for complexity, the latter enters through its pluralities vis-à-vis the explanation of experimental results, if available; otherwise the outcome of the corresponding theory becomes the matter of satisfaction alone for an individual or for a group of individuals. The most striking difficulty with the study of complex systems arises from the non-viabilities of the well known 'cause and effect' principle of physics for such systems. This principle, while expected to work successfully for all the so-called 'closed' systems and all space time mediated phenomenon in physics, for the working of complex systems, however, both cause and effect appear generally at different planes and often at different space time scales in spite of the fact that velocities involved in the system are finite. (Note that if the system involves infinite velocities, as is the case with psychic phenomenon or with the processes of mental world, cause and effect can appear non-locally in the language of physics and can also become non separable, i.e. they merge into each other. The immediate example of such a

complex system is an alive, functional human Being in whose actions all three parameters—space, time and consciousness, can work on the same footing).

With a view to understand the working of a complex system in philosophical terms, the so-called 'bottom-up and top-down' approaches [2,3] have been discussed in recent years. In this case the system-working can be analyzed in two distinct ways–either by starting with the face-value working of the system and then entering into the successively deeper domains of principles (bottom-up approach) one after the other, or by starting with deep desire of designing the system first in the mental domain and later in the successively evolving phases of practical life (top-down). As far as the viability of cause and effect principle in this case is concerned, some coherence between the causes and effects separately can be traced in these two ways of study. In other words, in the bottom-up approach there is a tendency to look for causes and effects from material zone to spiritual zone whereas in top-down approach it is just the other way round. The following example will further elaborate on these approaches:
Example: *Air plane as a complex system:* Suppose one plans to find answer to the question as to why an aircraft is flying. In the bottom-up case, it flies because air molecules move at different speed over the top and bottom wing surfaces to create a pressure difference that lifts the airplane against the gravity– Bernoulli's principle. In the same level terms, the airplane is flying because the pilot is flying it, after a vigorous training or testing process to develop the requisite skills. However, in the top-down picture, an airplane flies because it was designed to fly! A team of engineers at the same point desired and worked within a historical context of the development of metallurgy, combustion, lubrication, aeronautics, machine tools, computer aided design and so on. Further all this occurred in the economic context of the society and with a need for transportation. On the other hand, a brick cannot fly as it is not designed to fly, i.e., the intentions, will-power or desire was very much there to do the job. Here lies the subjective component in the whole discovery which came down to the practical level. Further note the three cases of this class of complex systems, namely (i) airplane toy flying with battery, (ii) airplane flown by pilot, and (iii) a flying bird.

While complexity in Nature is distributed all over (cf. Fig.2), it is only in recent years that the study of complex systems has become of great interest. Complex systems is a new field of science studying as to how the parts of a system give rise to the collective behavior of the system, and how the system interacts with its environment (surroundings). (It is worthwhile to point out here that in the present context the environment also consists of both living and nonliving objects and the interactions with them could be of different nature). The existing complex systems in Nature, which one can possibly think of, can broadly be classified as in Fig.2., namely (i) God-made, (ii) Man-made, which again have divisions and sub–divisions (cf. Fig. 2) and in the end each sub–division turns out to be a new complex system in itself.
Note that the God-made complex systems (cf. Fig. 2) are always dynamic in nature either because of the presence of the element of consciousness in them or due to their major contribution to the sustainability of the world-order. As a matter of fact sustainability in Nature can be understood better only through 'dynamism' and not through 'statism'. As far as the present studies of complex systems are concerned, they just move around some

selective ones. Although some of them belong to living category but the role of consciousness or its variants does not manifest directly in their studies. (For example, the complex systems of sociophysics, biophysics or for that matter of econophysics, are a few

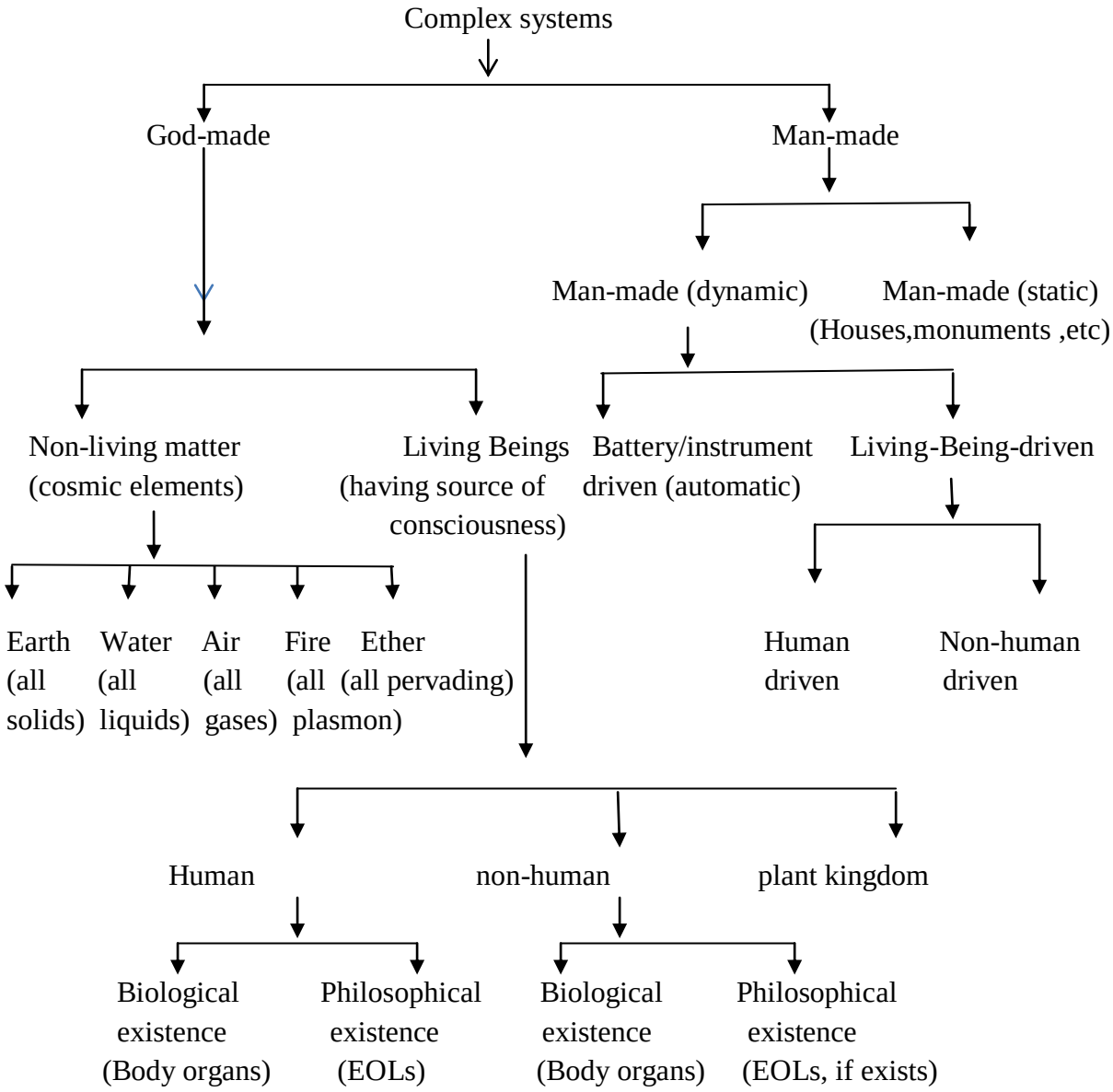

Fig. 2: *A broad classification of possible complex systems in Nature, based on their structure, substructures and working.*

such cases). In indirect terms, this role, however, is accounted through probability or randomness in the dynamics of these systems. For example, social systems formed (in part) out of people, the brain formed out of neurons, molecules formed out of atoms, the weather formed out of air flows, are some cases of current interest.

The field of complex systems, in fact, cuts across all traditional disciplines of science, as well as engineering, management, medicine and econophysics. It focuses on certain questions about parts, whole and their relationships, and these aspects of study indeed are very well

relevant to all traditional fields. Further, the viability of physics theories and tools in these studies, forces one to enlist these complex systems under the subjects of the so-coined as 'sociophysics', 'econophysics', etc, or in general as 'epiphysics'. Here we shall highlight one more discipline of epiphysics category which had been the part of psychology for the last 150 years and only recently its worth in physics community has been realized and that is the subject of 'psychophysics'. Note that the study of psychophysics is more fundamental and intriguing, than that of sociophysics or econophysics and in some sense it appears as a prerequisite for the further in-depth studies of sociophysics or econophysics. As mentioned above the social systems are formed out of individuals and the subject of economics offers only one of the utilities out of many to people or to the collection thereof.

Note that for more than a century now, there has already been a great deal of studies (as examples of 'epiphysics' and under the umbrella of applied physics) which are focused around the applications of physics and physical laws. This includes the subjects of engineering physics, chemical physics, biophysics, medical physics, agricultural physics, etc. In these disciplines, besides the use of methodology of science in general (i.e., the follow of the systematics: observation on a phenomenon, collection of data, correlation of data, search of a law, prediction and then verification of results, etc.), the use of basic laws and analytical methods of physics have also been exploited for a better understanding of the underlying phenomenon of interdisciplinary nature. As a matter of fact, a similar trend of study has been followed in these newly emerging disciplines of psychophysics, sociophysics and econophysics, of course after a gross use of analogies at different levels. Note that in these disciplines the objects of study invariably involve the human component or the living objects in general and hence one has to be very cautious while applying physics concepts and laws in such studies.

CHAPTER 3
PSYCHOPHYSICS IN ITS NEW INCARNATION: AN EMERGING DISCIPLINE

The subject of psychology is broadly classified into two categories, namely (i) differential psychology, and (ii) general psychology. The studies in these two categories are complementary to each other. In the former, one mainly concentrates on the studies of human behavior through the investigation of individual differences– largely in the areas of intelligence and personality, whereas in the latter, the emphasis remains on establishing broad general laws of behavior within such traditional areas as motivation, learning, thinking and perception. The differential psychologists, while heavily rely on the use of available quantitative techniques, the general psychologists, on the other hand, develop mathematical models of learning process and also the quantitative methods for this purpose. Lately the use of information theory, via data processing techniques, has further increased the scope of these studies. As far as the use of physics laws or of its analytical methods is concerned, no doubt, there is enough scope for them in these studies but mainly on the basis of analogies.

As early as in 1860, Gustav Theodor Fechner of Leipzig introduced [4] the subject of psychophysics which, according to him, is an exact science of functional relations or the relations of dependency between body and mind or more generally between physical and psychic worlds. Thus, in historical perspective, psychophysics is the branch of psychology that deals with the relations between physical stimuli and sensory response. Unfortunately, in the Western way of thinking, while the sensory world is well understood through the subject of physics (for example, the sense eye takes over the subject of optics, the sense ear takes over the subject of sound, the sense skin takes over the subject of heat through touch, etc.), the psychic or mental world is not explored to the same extent. As a result, the development of the subject matter of psychophysics somehow has not been kept in tune with other philosophies of the mental world or of mental processes and also with the progress made over the years in physical theories and brain sciences as well. While neuroscience has already started investigating the processes of learning, feeling and thinking in terms of neuron dynamics, the Indian philosophy, on the other hand, does offer [5] an elegant framework to study and analyze the entire gamut of human experiences in the finest possible manner and in terms of the so-called essence of life (EOLs). In fact the same stimulant of the physical world can leave different imprints on the minds of different persons depending upon the level of development of their faculties of understandings (FOUs). As a result, the role of FOUs of an individual in the perception process needs to be understood prior to relying on any conclusion drawn from the observations on the stimulant. In what flows we briefly discuss a well studied framework of Vedic science for this purpose.

3.1 Some undeniable facts about the human Being as per Vedic wisdom

(a) Essence of life (EOLs) and their arrangement: We all have biological body (B) consisting of inner and outer organs in it; we do have ten senses of knowledge and action (SE) (five senses of knowledge are eyes, ears, nose, tongue and skin, respectively sensitive to light, sound, smell, taste and touch and five senses of actions or motor organs are hands, feet, speech, anus and copulatory organ). They, in conjunction with the stimuli from the worldly object (WO) constitute the set of outer EOLs. The other set of inner EOLs consists of mind

(M), intellect (I) and ego (self-sense) (E) which respectively are responsible for defining the faculties of 'emotion', 'decision' and 'memory' inside the human Being. Notably they all are like inanimate objects but work and become functional only in the presence of another nonphysical element called 'consciousness' that originates from, what is termed as 'soul' (SO)– the innermost existence present in a Being and cannot be denied (since a dead body, in spite of having all these EOLs cannot act and becomes functional in the absence of SO alone). A human Being (b) (also called as 'Jiva' or life principle) is a composite entity of all these inner and outer EOLs who, while having a strong base in SO, does work consistently in the field of WO.

With regard to the arrangement of these EOLs in a human Being (cf. Fig. 3), they follow an atom-like picture at the mental level. For this purpose, a patomic (philosophical atom-type) model of human Being has been proposed earlier [2,5,6] by the author in which the nucleus WO is in the centre and the discrete (energy) states B, SE, M, I and E are placed around it in accordance with their increasing fineness and the strength of the meditation. (Meditation is a process in which one uses the focused and/or directed consciousness or the so-called attention to peep into his own inner Self). Much beyond the state E it is all continuum of SO. Note that this gradation of various states, in which an electron-like object b can stay and according-

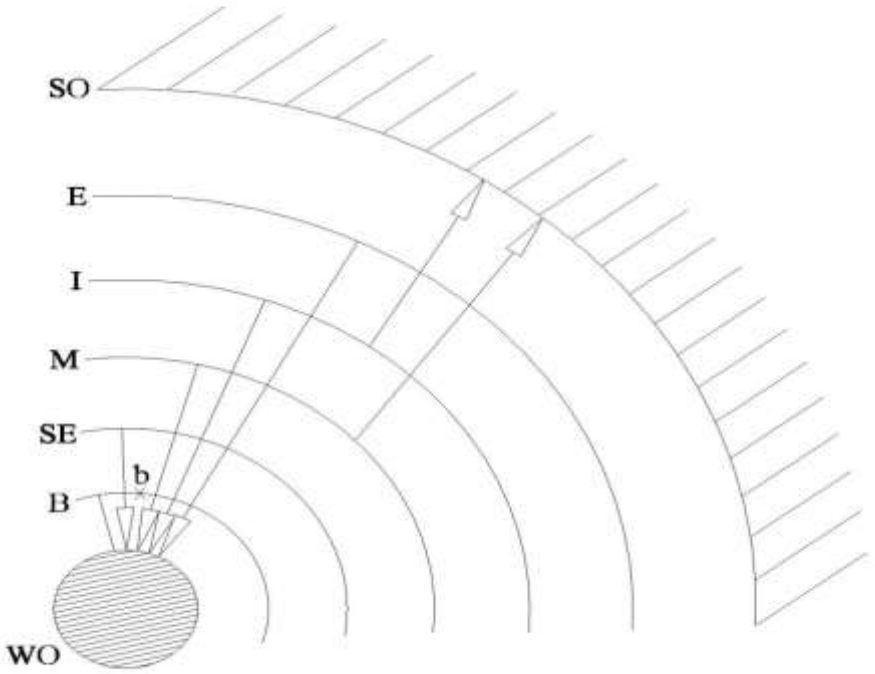

Fig. 3: *Philosophical atom-like Model of Human Being.*

-ly perform upward and downward transitions, is on the scale of meditation and not with respect to the physical space time. Further, while the upward transitions of b are rare, the downward transitions are natural and more frequent. Even on the meditation scale the increasing spacing between successive states, in fact, corresponds to a rigid binding/rigid rotator in quantum mechanics between the Being b and the worldly objects WO. Also, note that such an arrangement of EOLs in a human Being that includes the role of SO in it, is subject to expose to a finest possible cosmic consciousness field in the Universe, in the same way as a functional mobile hand–set (which contains a battery in it) is exposed to the electromagnetic signal spread all over in the space. Interestingly, such a philosophical picture of a human Being has suggested several new dimensions of study in the personality creation and development theory of Jung [2,7] with reference to the spirituality quotient.

(b) Grouping of EOLs simplifies the understanding of underlying mechanism leading to human actions: While trying to analyze the human behavior in terms of the dynamics of EOLs, no doubt the role of each EOL needs to be accounted for at a deeper level but some gross features of behavior and personality traits can be understood (see, Ref. (7), and Ref. (2), Chapter 9) just by grouping the outer EOLs as gross body ($\mathcal{G}$) as $\mathcal{G}\equiv${WO, B, SE}, inner EOLs as 'micro' body ($\mathcal{M}$) as $\mathcal{M}\equiv$ {M, I, E} and the only EOL SO as 'causal' body ($\mathcal{C}$) as $\mathcal{C}\equiv$ {SO} as per Vedic science. In this way the (perfect human) Being b basically is a union of $\mathcal{G}$, $\mathcal{M}$ and $\mathcal{C}$, viz., b= $\mathcal{G}\cup\mathcal{M}\cup\mathcal{C}$or it is a set of all EOLs, i.e. b ≡ {WO, B, SE, M , I, E, SO}. Further note that the absence of any one or more EOLs in b constitute the classes of physically or mentally challenged persons or of nonhuman Beings (cf. 'fractured' patomic model, see Ref. (5)). As a matter of fact such a grouping of EOL has been helpful in explaining a variety of aspects of human actions, human and nonhuman interactions, etc. at least in the lowest order.

(c) Faculty of understanding and its level of development in an individual: In analogy with a generalized version of '*pancikaran*' rule of Vedic science known for the perception of five cosmic element (*panca mahabhutas*), namely earth, water, air , fire and ether, a '*tri-karan*' rule for inner EOLs M, I and E and a '*dvi-karan*' rule for the outer EOLs B and SE is proposed [5]. These rules in fact define the dressing of an object with consciousness in different orders through some sort of symbolic recurrence relations and thereby suggest a mechanism to differentiate clearly between dressed (perceived) and undressed (unperceived or nascent) versions of entities which are generated in a self-consistent manner. There rules have greatly helped [5] in understanding the perception process in a more logical manner. Here, however, we emphasize only on the *tri-karan* rule for the dressing of inner EOLs from their nascent version M, I and E. As a matter of fact, the faculty of understanding of an individual is a composite (set) of differently dressed versions of his inner EOLs with his own consciousness, viz., $\widetilde{F}^{(l,m,n)}=\left\{\widetilde{M}^{(l)},\widetilde{I}^{(m)},\widetilde{E}^{(n)}\right\}$, where $\widetilde{M}^{(l)},\widetilde{I}^{(m)}$ *and* $\widetilde{E}^{(n)}$ are the l-th, m-th, and n-th order dressed versions of $M\left(\equiv\widetilde{M}^{(0)}\right), I\left(\equiv\widetilde{I}^{(0)}\right)$*and* $E\left(\equiv\widetilde{E}^{(0)}\right)$, respectively and according to the *tri-karan* rule they are given by the recurrence relations

$$\tilde{M}^{(\ell)} = \frac{1}{2}\tilde{M}^{(\ell-1)} + \frac{1}{4}\tilde{I}^{(\ell-1)} + \frac{1}{4}\tilde{E}^{(\ell-1)} \quad , \qquad (2a)$$

$$\tilde{I}^{(m)} = \frac{1}{2}\tilde{I}^{(m-1)} + \frac{1}{4}\tilde{E}^{(m-1)} + \frac{1}{4}\tilde{M}^{(m-1)} \quad , \qquad (2b)$$

$$\tilde{E}^{(n)} = \frac{1}{2}\tilde{E}^{(n-1)} + \frac{1}{4}\tilde{M}^{(n-1)} + \frac{1}{4}\tilde{I}^{(n-1)} \quad , \qquad (2c)$$

where l, m, n= 1,2,3, …. , ∞. For details of dressing rules we refer to Chapter 8 of Ref. (5). Here, however, we have demonstrated in a nut-shell that all three mind, intellect and ego of an individual get enriched with their respective intrinsic characteristic when they are constantly exposed to his consciousness through the process of meditation.

In relations (2), the three limiting cases corresponding to l, m, n→∞, while separately define three ideal personalities, namely the most emotional, the most intelligent, and the most learned, respectively, for a common man, however, one can define an index r as a set of integers l, m and n, viz., r ={ l, m, n} which characterizes the level of development of one's FOU. Further note that the order of dressing of an EOL in general is a measure of intensity of meditation attained by an individual. Such an interplay of inner EOLs has already offered explanations of variety of aspects of human behavior and experiences [5,7]. We refrain ourselves from going into these details here. Not only this, there is a possibility of finding a basis for the incomprehensibility principle of Fraser [8] which everyone experiences in the day-to-day life towards the success of an action, namely the intensity of meditation/concentration is inversely proportional to the duration for which it is applied. In this context these dressing rules become an asset while defining the intensity of consciousness or looking for the coordinate-momentum coupling at the most fundamental level [9-11].

3.2 Human behavior and environment

(a) Human actions and their patterns (behavioral dynamics): As far as the analysis and understanding of human actions is concerned, the same has been carried out in psychology in modern times mostly by using statistical methods and the so-derived empirical models. A formal and absolute approach to understand the subject matter and the collected data in terms of certain minimals at the input level, is somehow missing. The proposed patomic model of human Being which has roots in Vedic science (cf. point (a)-(c) in Sect. 3.1) in some sense, can prove to be a powerful alternative for the experts. For this purpose one can start analyzing actions in terms either of ways, namely using grouped EOLs (cf. point (b) in Sect. 3.1) but for studies at a crude level or using individual EOL (cf. point (a) in Sect. 3.1) for studies at a finer level. As far as the 'karmic theory' of Vedic-science is concerned there is enough scope for studying further deep features of human actions (cf. Chapter 8 of Ref. (5)). As a matter of fact a systematic study of dynamics of these EOLs in an individual defines a broad spectrum of human qualities, a pattern of which, reflects the so-called his personality or the behavior at a later stage [7].

When such a picture of human Being (i.e., patomic model) interacts with the outer world—consisting of both inanimate and animate objects (stimuli)—a new dynamics (which basically differs from the one that appears for physical atoms, mainly because now the role of free-will and consciousness of participating humans appears in the system) emerges. Attempts are made [2,5] to understand this dynamics, of course by way of having certain lessons from the existing physical theories. In fact, a study of these interactions becomes an asset with reference to the personality development and character building by an individual [7]. In these studies, also there emerges an art and science of integrating body, mind and soul towards the success of an action.

(b) Two, three and many human Being interactions (collective behavior and sociology): Keeping in mind the roles of will-power and consciousness of an individual, a theoretical understanding of fundamental processes involving two, three and many human Being interactions is developed in analogy with several physical concepts and many-body theories in physics. As far as the role of patomic model of human Being in these studies is concerned, the same appears in a somewhat different way from that of atomic model of matter. In the latter case, while valence electrons play a dominant role in many atom systems, here, however, the Being b participates in the interactions in two distinct ways, namely in an 'inside out' or in an 'outside out' manner depending upon the process and the environment and that too with equal probabilities. In some sense, the level of development of one's FOU also matters in this regard. For further details we refer to Ref. (5) and Chapters 6, 12 and 13 of Ref. (2).

3.3 Use of physical theories in understanding psychic phenomena and processes

No doubt, known physical concepts and theories by and large are used in an analogous manner [1] for a better understanding of human behavior and experiences [2,5] but in these endeavors it has become possible to model and formulate several new psychic phenomena in terms of the dynamics of EOLs, i.e., a step towards the quantification of consciousness and that too in an alternative style. In what follows, we briefly highlight some such applications of physical theories and concepts pursued to better understand the subjective Science of the Self.

(a) Understanding the individual

(i) With reference to an individual, a philosophical atom-type (patomic) model of human Being (cf. Sect. 3.1 (a) and (b)) in analogy with atomic model of matter is designed. This model, in fact, has facilitated the understanding of a subtle dynamics of EOLs including the role of consciousness in the action performed by an individual. The model is viable enough to apply it in other disciplines in which the human Being is involved as a participator in the underlying processes.

(ii) The dressing rules whose glimpses are given in 3.1(c) above basically are the recurrence-type relations originated out of the extension and generalization of *panci-karan* rule of Vedic science for five cosmic elements (see Ref. (5), Chapter 8). These rules in fact, have greatly facilitated the understanding of the perception process at the most fundamental level– a long standing problem of panpsychism in psychology [9].

(iii) The concept of exchange of a quantum between the interacting particles in modern physics has inspired to extend and generalize the concept of *tanmatras* known already in Vedic science in the context of interaction of a human Being with five cosmic elements (*panca mahābhūtās*) at subtle level (cf. Ref. (5), Chapter 8). A variety of new *tanmatras* is introduced to understand the interactions inside the human Being at a subtle level (see, Ref. (5), Sect. 8.4.3).

(iv) In analogy with the Hamilton principle of least action, human Being also prefers to follow the path of minimum efforts. To this effect, attempts are made to formulate the principle of minimum efforts by way of optimizing a particular type of functional called mindset function (see, Ref. (5), Sect. 8.8).

(v) With a view to accounting for the consciousness in physical theories and in continuation of (iv) above, a possible generalization of principle of least action and accordingly that of Lagrange equations of motion is carried out [12]. This we pursue: (A) by way of considering the complexifications of the Lagrangian in function space and also that of the variables separately in distinct ways, (B) by introducing the meditation variable (as a measure of consciousness) and treating it at par with the time variable and thereby (C) by exploiting the method of calculus of variations for space-time-consciousness evolution of a psychophysical system.

(b) Understanding the collection of individuals

As far as the exact studies of three and many-body physics is concerned, it has always been (and still it is) a difficult problem irrespective of the nature of interactions among them. As an alternative, either approximation methods have been employed for this purpose or in the limit when the number of interacting objects becomes large, statistical methods are used. It may be mentioned that the same (or rather more difficult) is the case with three and many-human-Being systems in a family or society. The reason being the presence of free-will, intellect and in general consciousness in each of the interacting body and their active role in the dynamics of living systems further complicates the problem. Objective scientists while are afraid of treading into this domain of reality, subjective scientists, on the other hand, do a lot in this regard but by using their limited analyzing power and intuition. In such a situation, particularly in the absence of availability of any formal theory for a living human Being or its collection, the understanding of many-human-Being systems remains rather poor. Patomic model of human Being outlined above, however gives some hope in this regard.

Note that, in the same way as in physics, few-human-Being systems are better understood than many-human-Being systems. In fact, the use of reduced version of patomic model in terms of gross, micro and causal bodies has greatly facilitated the understanding of human-exchanges but in the lowest order. At a finer level, however, one has to account for the role of individual EOLs in the exchange [5]. With regard to the study of many-human-Being systems one can have several lessons from many-body theories in physics and with reference to the patomic model of an individual (see, Ref. (2), Chapter 12). As a matter of fact, as compared to physics-systems, now there appear several uncontrollable parameters in the theory of psychophysical systems which basically are highly open systems to environment. This, in turn, questions the viability of physical theories when applied as such to

psychophysical systems. In spite of all this, some analogous applications of physical theories have been discussed earlier [2] within the framework of patomic model. In what follows, we just advance some remarks in this regard:

(i) After introducing the concepts of 'outside out' and 'inside out' interactions within the framework of patomic model, attempts were made to explain the interactions of a human Beings with other humans and physical world. The formation of groups and subgroups (or cults and sub-cults or castes and sub-castes) in a society appears natural in this scheme of study. A core-valence picture used in atomic and nuclear physics now shows the way for such applications. For example, when this valence arise from deep inside the patomic model, i.e. from M, I or E states and the same contributes individually to the collection of individuals (Fermi-like gas model), then the corresponding group of persons is defined as that of intellectuals or feelers. (For, details, see Ref. (2) Sect.12.5). Such studies would definitely give a new dimension of thinking to understand the dynamics of social systems.

(ii) Another way to understand a many-body system in physics is by bombarding it with a particle whose interacting feature preferably also plays a role directly or indirectly in the interactions inside the target system. Note that, the theories of collision phenomenon are classified on the basis of energy scales and/or the nature of interaction(s) of the bombarding particle with the constituents of the many body system. In the same way, if one wants to know about a group of persons or about an organization, then he has to find ways and means to interact with the members of the group or of the organization. Not only this, he has also to know the nature of the core and peripheral workers in the group. As another example, if you want to know about your non-interacting neighbor, then you start interacting with the children of that family and you can extract a lot about the family from such interactions through children. These are examples of one-to-many human Being interactions.

(iii) There are cases of many to one human Being interactions in practical life. (Such cases are not so common in physics). For example, when a teacher, politician or a saint is bombarded with a series of questions in response to his lecture/address/discourse, then such a situation arise.

(iv) A peculiar case of human interactions is quantified (see, Ref.(2), Sect.12.5.3) in a statistical framework using the so-called 'Saha ionization formula' in physics proposed by M.N. Saha in 1931. Using this formula and the patomic model of human Being one can easily compute the fraction of the audience benefitted most from the lecture/discourse of a teacher/saint.

CHAPTER 4
SOCIOPHYSICS AS AN EMERGING DISCIPLINE

As far as the involvement of physicists in social science and business studies is concerned, it has been there for centuries. Daniel Bernoulli in 1738 introduced the idea of utility to describe people's preferences. Pierre-Simon Laplace in 1812 pointed out that events that might seen random and unpredictable in daily life, can be quite predictable and can be shown to obey simple laws. Later these ideas of Laplace were further elaborated by a student of Joseph Fourier, named Adolphe Quetelet who studied the existence of patterns in different data sets and coined the word 'social physics' in 1835. Further in 19th century Irving Fisher, a student of Willard Gibbs discussed the role of physics in the development of economic theory, mostly on the basis of analogies. Later, famous nuclear physicist, Ettore Majorana in 1938, analyzed the viability of statistical physics methods when used in the studies of social phenomena. For an answer to the question as to what extent physical theories can be viable in studying sociology and economics, we refer to recent articles in Physics Today [13,14].

4.1 Sociophysics has roots in psychophysics and viability of physical theories

During the last few decades there has been considerable interest (see, for example, Ref. (15)) in studying the subject of sociology as a dynamical system and in fact, why should it not be! After all, the ever growing scientific advancements are drastically affecting the once considered as 'static' society. To this effect, a fine tuning in studies is achieved by using not only the advanced mathematical methods but also the analogies from physical theories [16].

In preceding sections and earlier works [2,5] we have tried to analyze as to how the dynamics of EOLs of a person play an important role in shaping his action, character and later, personality. For this purpose, the subject of psychophysics in its new incarnation is developed and the tools so emerged have proven as an asset in understanding the entire gamut of human behavior and experiences in terms of certain fundamental processes that take place at subtle level among various EOLs. Further it is noticed that there exists a plausible and viable framework of patomic model to understand the social psychological dynamics from the individual based psychophysics. In this section, we further elaborate on the subject and discuss as to how the communities or subgroups of individuals of different tastes and cultures contribute to the dynamism of a society as a whole. We use again the physics concepts and theories but now for different type of systems and at different scales.

As to how the study of sociophysics emerges from that of psychophysics can be understood from the following analogy: If one wants to understand a gas in terms of molecules or a solid in terms of atoms, where an understanding of molecule or an atom in terms of their structure already exists, then note that the force laws at molecule level or at atom level would be different from those of at their constituent level. In fact, similar is the case when many individuals come together and constitute a society. Note that individual psychology as such does not constitute the collective psychology in a simple additive manner. Like in gases or solids, here too correlations and consequently, the forces characterized by their strength and range become different at collective level from that at individual substructure level.

Further note that the forces are contact or action-at-a-distance type and they are space time mediated all through-out for physics systems but for human-Being-systems it is not so, they as well could be action-at-a-time (derived from the history of society) and/or action-at-a-distance time (derived from both the geography and history of society) type in addition to the contact and action-at-a-distance type. They can as well involve roles of consciousness and/or of mindsets of people and the same need to be incorporated even in physical theories through a meditation variable [12]. This feature of force laws for human-Being-systems in addition to the fact that they are the open (to circumstances and environment) systems, reduces the viability of applications of physics concepts and theories as such to human-Being systems. In such a situation there are three possibilities: (i) alternative theories need to be developed for social system on the lines of a physical system, (ii) physics theories need to be modified to accommodate 'human features' pertaining to consciousness, or (iii) the existing theories of physics can be used with a rider and in the lowest order of predictive power. The important point is that the strengths and ranges of the forces involved do not change in the present case of many-human-Being system as in physics. They almost remain the same all throughout when one proceeds from individual to a collection of individuals. In summary, it may be emphasized that physical theories and concepts, developed basically for inanimate objects, cannot be used as such for animate objects like human Beings whether at individual level or for their collection. However, the patomic model in its crude or reduced version [5] can prove to be an asset in these studies.

Next comes the question of change in a social system with respect to space, time and circumstances. In this regard, note that a physical system, often assumed to be closed as is generally the case, undergoes changes with respect to a single time scale defined conveniently with reference to the external observer or at the best with reference to the cosmic time scale (Big Bang). The dynamical variables here mostly have intrinsic dependence on time and the explicit dependence on time, if it is there, is often neglected since the available mathematical tools are still inadequate [17] to account for it. In a social system, however, there are many time scales, besides the ones with reference to the external observer and cosmos. As a matter of fact in a social system the consciousness of each individual subsystem is capable of creating its own time, space and geometry and hence complicates the studies of the system as a whole and also projects the system as a 'complex' system. Further, (i) subsystems (individuals) are now no more closed systems then what to say of the social system as a whole and this limits the viability of physical theories for this purpose, (ii) explicit dependence on time is bound to be there and hence the application of physical theories as much is not justified, and (iii) even in an individual, the change can occur at the level of all EOLs, viz., body, senses, mind, intellect, and ego, but in the presence of soul. Some of these difficulties, no doubt, are overcome by using the methods of statistical physics or statistics in general. But in view of the presence of 'free will' and 'will power' in the subsystems, the question arises as to how long the rules of inanimate dice will be applicable for a collection of living as well as interacting systems. In nut-shell, in order to develop a formal theory for social systems a feedback has to come from the psychophysics of new incarnation (cf. Sect. 3). An important point to be noted here is that for social systems the change takes place not only with space and time but also with respect to the circumstance created by the mindset (a representative of consciousness) of individuals or of their

collection. This constitutes the subject of social psychology. In some sense the situation here is similar to that when the probabilistic interpretation of the quantum wave function was advanced and prompted Einstein to remark that 'God never plays a dice'.

4.2 Social Experiences and the underlying dynamics

There was a time when societies or social life of a person was almost static for centuries if not for decades; but now, in view of the everyday increasing scientific advancements towards a luxurious life style, both culture and society are undergoing a fast change. This has not only brought the dynamism in the society but has considerably affected the psychology of an individual and also the values in society. Naturally, this type of dynamism is not the same as one studies for physical systems. Here, the subjective element in the psychology of society dominates over the objective one contrary to a physical system. In recent years, there have been several attempts (made on the basis of some limited experiences) to account for this kind of dynamism (see, e.g. Ref. (16)) in a social system. However, the viability of these rather disconnected and empirical approaches remains highly restricted mainly because they borne out of some limited experiences. In the following we highlight some of these methods:

(a) Cyclic phenomena in some social psychological experiences: During the last few decades there has been growing interest in studying the cyclicity in social psychological phenomena. In fact there appear several spatio-temporal-patterns associated with various biological phenomena, which display periodic structure as a ubiquitous feature of personal, interpersonal and social experiences in a variety of situations in humans and also in nonhumans. For example, the case of circadian rhythms related to internal biological clocks is well known. These rhythms, in fact, are coordinated with external cues, such as patterns of light versus darkness, the gravitational rug of the moon, barometric pressure, earth magnetic field affecting the brain functioning, and so on. As examples, we list a few such cases here:

(i) Interest in circadian rhythms in human was in part inspired by the phenomena of jet lag and the need to cope with the desynchronization of one's internal biological clock. It is observed that pilots who fly on routes from south to north, which tend to be associated with climate changes but not time-zone changes, experience much less stress and exhaustion than do pilots who fly on east-west routes, which do entail time-zone changes but often little change in climate.

(ii) The desynchronization of internal clocks is also an issue for shift workers in industry, who must reverse their daily cycle of sleep and work. Studies have shown that the synchronization is provided by the day-night cycle and is mediated by melatonin concentrations in the brain. It is also noticed that the various internal clocks tend to be synchronized with one another, often in the form of embedded cycles. In fact, there could be various biological and psychological characteristics occurring periodically within 24-hour sleep-wake cycle, which later on, in turn, are embedded in monthly and seasonal rhythms.

For further examples of such rhythms and periodic structures of biological and social nature in human actions we refer to the work of Nowak and Vallacher [15]. Until recently the understanding of these phenomena has been mostly descriptive. It is only during the last two decades or so that advanced mathematical methods have been employed with a view to having better analytical studies and predictions from models. For example, Fourier analysis has been employed to study the temporal evolution of a system involving embedded cycles

by the superposition of different periods. While the use of methods of nonlinear dynamics is already known now for a quite some time in the studies of population dynamics [18], the tools of stability analysis, bifurcation and chaos, etc. have also been employed with a view to achieving a sustainable society at least in idealized conditions.

(b) Cellular automata: This class of models is used to investigate collective phenomena reflecting the interaction of individual elements in complex system, for example, that of individuals in a society. Cellular automata are discrete dynamical systems in that they are composed of specified number of elements, each of which can adopt a discrete number of states at discrete points in time. The basic unit is a cell representing an individual component of the system under study. Alternatively, each cell represents a single particle in a fluid in models of hydrology, a single particle with magnetic orientation (spin) in models of magnetic phenomena and single tissue cell in models of biology. Independent of the application, each unit (cell) in this model adopts one of the discrete states (often only two). The cellular automata is composed of large number of such cells which are arranged in a well defined spatial configuration, such as 1-dimension line or 2-dimension lattice etc.

With regard to the working of these models, the state of a cell is considered to depend on the states of neighboring cells and is dictated by the so-called up-dating rules. One of the simplest up-dating rules is the majority rule. The latter specifies that a cell at time t+1 will adopt the state characterizing the majority of its neighbors at a time t. In fact, different neighborhood structures are possible for cellular automata models. In social science applications, cellular automata are primarily used to study the emergence of group-level phenomena from individual-level interactions. In this case, each cell corresponds to a single individual, and the state of the cell may represent individual characteristic such as opinions and attitudes, decision and so forth. A common assumption made in these studies is that each individual's interactions are limited to neighboring cells and that the outcomes of these interactions determine the state that each individual adopts. In fact, a variety of social psychological issues have been investigated within this framework with a considerable success on some fronts. For further details we refers to the Ref. (16).

(c) Connectionist models : This class of models is also known as artificial neural network models because their architecture resembles with that of a nervous system, i.e., elements are analogous to neurons and connections among them are analogous to synapses. In fact the basic feature of connectionist models is that the state (activation) of each element in a system is determined by the total influence (excitatory minus inhibitory) from other elements across connections. Also, these models offer good examples of basic principles of dynamical systems mainly because the state of element at one moment in time depends on the state of the elements to which they are connected at the preceding moment of time. In this regard, these models do have some similarity with majority rule in cellular automata models. In recent years, these models have become the object of active research in the study of cognitive processes after the working of Rumelhart and McClalland [19] and Smolensky [20]. Note that, in general, connectionist models do offer somewhat better explanation of a social psychological phenomenon than other class of models, particularly when there is a question

of accounting for the experience of competing forces within an individual or for the dynamics of interpersonal thoughts and behavior.

(d) ***Social systems as nonlinear dynamical systems***: In terms of complexity we have seen that the working of a social psychological system is as complex as the functioning of human brain. The main factor which dominates this working is the interplay between causal mechanism (i.e., the causal links between various variables) and dynamical processes (i.e. the evolution of the system in space and time). To this effect, a common basis underlined in almost all above mentioned classes of models is that the state of the system at any moment in time is determined by the state of the system at the preceding moment, so that an effect at one time may operate as a cause at the next. Further note that the nonlinearity in a social system (as compared to physical system) is a built-in feature that manifests at every stage of causal connections. In other words, when external influences are present, the system's behavior may change in a manner that is non-proportional to the magnitude of the influence. In fact in these studies one not only requires a stable equilibrium in the system but also looks for a self-sustainability in it and that too, in the presence of various nonlinear causal connections. In this regard the traditional methods of analysis while show their limitations, the methods of nonlinear dynamics [21], on the other hand, are expected to provide more effective and viable results in practical terms. The spirit behind these methods can be described as under:
Let the state of the system at time t be fully described by specifying the actual values of all the dynamical variables, $\chi_1(t), \chi_2(t), \ldots\ldots, \chi_n(t)$. The values of the say, i-th variable, χ_i , at time (t+1) is described as a function f_i , of the values of all variables at time t, viz.,

$$\chi_i(t+1) = f_i[\chi_1(t), \chi_2(t), \ldots\ldots, \chi_n(t)] , \qquad (3)$$

or, one considers the set of n differential equations for the case of continuous evolution, namely

$$\frac{d\chi_i(t)}{dt} = f_i[\chi_1(t), \chi_2(t), \ldots\ldots, \chi_n(t)] \qquad (4)$$

for i=1, … , n. In general, in mathematical terms, one looks for the existence and solvability of such a set of coupled differential equations for a linear and /or for a variety of nonlinear versions of the function f_i (for further details we refer to Ref. (21), Chapters 6 and 7). Alternatively, the rules underlying the evolution of the system may also be described in geometrical terms. The set of members $\chi_1(t), \ldots, \chi_n(t)$ can be considered as a set of coordinates in an n-dimensional space which in conjunction with their derivatives, $\dot{\chi}_1(t), \dot{\chi}_2(t), \ldots, \dot{\chi}_n(t)$, constitutes the so–called phase space. For some finite-dimensional systems (or for small values of n) it is possible to understand several interesting salient features of the system through some geometrical figures (the so-called 'phase portraits') on the $(\chi_i, \dot{\chi}_i)$ phase plane. The nature of these phase portraits helps in revealing not only the stability and instability of the system with time but also their interplay in the evolution as a function of certain underlying parameters present in the system (the phenomenon of bifurcation). These studies while pertain to the regular motion of the system, certain types of nonlinearities present in the model also yield irregular or chaotic motion which again is revealed by these phase portraits.

4.3 Dynamical social psychology: Scope of mathematical modeling

Keeping above features of a social system in mind and noting the limitations of physical theories regarding their use in soft disciplines in general, it becomes clear that the latter theories cannot be used as such in true sense, but only in an analogous manner. Further recall that an analogy can never be a reality even if it is of finest order (cf. Sect. 1.2), it can only hint to reality and that too after showing agreement of the predicted results with experiments. When there is a lack of understanding of consciousness itself or its role in the dynamics of EOLs working-through human or social actions in the Western thinking then how can one expect a good prediction from such theories and models [15,16]. Truly speaking the use of physical theories can only describe the space-time evolution and hence only the partial truth about the system. The theories corrected for the role of consciousness or developed independently as an alternative for a human system can however be expected to yield better results. Some glimpses of such considerations are already given in the previous section in terms of the patomic model. As a matter of fact there appears a timely need to apply these concepts of Vedic science while studying and/or analyzing a social system. In this regard it may be mentioned that Vedic science offers much more than necessary for a social scientist of Western thinking.

It is believed that the most advanced tools, methods and concepts of natural sciences may ultimately have greatest applications in social psychological studies. To this effect, such notions as spatio-temporal chaos, self-organization and unpredictability may find better applications in social sciences than in physical sciences. As far as the use of physics concepts and mathematical modeling in the study of social phenomena is concerned we list here a few situations as examples, following the work of Nowak and Vallachar [15], where the intrinsic beauty and effectiveness of these tools of study is demonstrated.

(i) Although the network theories (via lattice dynamics or lattice gauge theories) were developed in physics, it turned out that the brain– a well entrenched topic of biological and psychological inquiry– provided the most appropriate example of these studies.

(ii) Nonlinearity in system behavior: It may be recalled that the nonlinearity in physical theories, developed mostly in the last century, was tactfully avoided perhaps due to non-availability of tools at that time to handle it in mathematical terms. Now, when the subject has considerably grown in mathematical sciences [21], its scope of applications can be found more in psychological and social studies than in physical sciences. For example, logistic and couple logistic equations [22] have their own role to play in various models of dynamical social psychology. This equation in fact involves repeated iteration of the quadratic function in which the values of the variable B vary as the square of the values of variable A.

(iii) Hysteresis: The phenomenon of hysteresis, well-known for magnetic materials in physics in the form of magnetic field vs. intensity of magnetization curve, is basically a manifestation of nonlinearity in the features of the system [23]. This phenomenon in general refers to the fact that the variable Y may be in two different states for a single value of variable X. Which value of Y is observed for a given value of X, depends on the history of change in Y. If Y has the history of low values, X must take on relatively high values to cause increased values of Y. On the other hand, if Y has history of high

values, X must take on relatively low values to cause decreased value of Y. The range of values of X for which Y can be in two different states is referred to as the hysteresis region. In this region, note that the changes in Y might go under both continuity and discontinuity. The phenomenon of hysteresis may prove to be a common feature of social psychological system and its study in fact may be critical to probe the relative stability of a dynamical system, in general.

As discussed in Sect.3.1, there are several factors which resist the study of social psychology in a truly scientific spirit, particularly in the way of physics. The remarkable complexity of human thought, behavior and relationships makes these studies difficult. As a matter of fact, the success of dynamical system theories in natural sciences is largely due to its ability to provide simple explanation for complex phenomena pertaining mainly to inanimate objects whereas in social dynamics (for that matter even in behavioral economics) the objects of study are the living (human) Beings and the presence of consciousness and hence free-will in them complicates the studies. In reality, in the latter case one would however require a different type of modeling and the dynamics as well.

4.4 Role of (individual) mental dynamics in social actions

It is true that the mental dynamics of an individual, incorporated through the patomic model (cf. Sect.3) not only reflects in his actions, behavior and personality [2,15] but also affects the society in which the person lives in provided such personalities dominate in society. In response to the question as to how to account for this individual's role in the collection of individuals (i.e. society), some methods in analogy with many-body theories in physics are already discussed in Sect.3.3 (b) within the framewotk of patomic model. In fact, further studies in this direction are desirable mainly because the patomic model takes one a step little deeper into the psychological domain as compared to the Western way of thinking.

Before proceeding further, it is worthwhile to spell out the basic difference between the Western and Eastern (Indian) philosophies of human actions performed in this world [2]. In some sense they respectively correspond to the bottom-up and top-down approaches adopted in recent times to study complex systems or to the 'matter over mind' and 'mind over matter' approaches in philosophy (cf. Ref. (2), Chapter 4). Whenever the role of consciousness in human actions (which can not be denied from any angle) is talked about, it is just attributed to a philosophical entity called 'mind' in the Western way of thinking. This is done again without really understanding to what this philosophical entity 'mind' is? Not only this, the reasoning and memory are also included in addition to emotions among the attributes of mind,. Further, the source of these attributes is traced in the structure and the functioning of the 'brain' – a material part of the body. Truly speaking, in the Western way of thinking mind is one complex system, whose working one tries to understand in terms of another complex system of different category and scale, i.e. brain without really understanding the consciousness and its associated phenomena inside a Being. The latter, in fact, is in the root of working of both mind and brain. A dead body does not have a functional brain or mind. As a matter of fact, it is the same consciousness which makes the brain functional on the one hand and also creates an environment on the other at the same time not only for the mind to

work but also for other faculties of understanding. These faculties particularly are responsible for reasoning and memory in a human Being [2,5]. Thus, the Western thinking while ends up with the entity mind, the Indian philosophy on the other hand, goes one step further and clearly and distinctly accounts for the roles of faculties of reasoning (i.e. intellect) and of memory (i.e. ago or self-sense) in human actions. In fact a great deal of Vedic philosophy revolves around these considerations along with the studies of the source and phenomena of consciousness in a Being in general.

Truly speaking the role of individual mental dynamics in social actions need to be analyzed in two steps– at the first stage, study the individual's behavior either in isolation or in an environment (consisting of both animate and inanimate surroundings) and then, at the next stage, study the correlation, cooperation, coordination, relationship capacities etc. of this personality with other person(s). Even physics-based analogous models in this regard show the limitations mainly because of the presence of free-will, will power or consciousness in general in the object of study. Nowak and Vallachar [15] underline this entire gamut of study under four heads, namely self-organization of action, coordination of mind, dyfunction in action systems, and a dynamical taxonomy of action. It is needless to say that the Vedic wisdom through the methodology of patomic model [5,7] in conjunction with dressing rules (cf. Sect. 3.1) can add a lot to these studies. We however refrain ourselves from going into these details here.

CHAPTER 5
ECONOPHYSICS AS AN EMERGING DISCIPLINE

5.1 Status and role of physics in economic sciences

The possibilities of marriage between economics and physics have been discussed in recent articles and books [13,14,25]. Pimbley [13], while discussing the status and value of physics and physicists in economic sciences, however does accept the existence of creativity element in physicist in handling the core problems of a given subject. However their insufficient basic training in the concerned subject like economics entails a handicap in the development of the subject. On the other hand, Doyne Farmer et al [14] are optimistic and believe that the interdisciplinary training for students/researchers can perhaps yield better results. Doyne Farmer et al further highlight the solution to certain economic problems using the physics concepts, theories and models. As far as the uses of the latter are concerned, they are carried out mostly in an analogous manner. Note that such applications of physics in economics can no doubt facilitate the solution and handling of the core problems but this will hardly throw any light on the ultimate reality in Nature, mainly because economics itself is a science of utility to mankind and as such is not the science of fundamental nature like physics. After all, the goals and philosophy in the two disciplines are different. The following discussion will further elaborate his point.

Note that the subject of psychophysics is entirely developed for the understanding of the role of human component in soft disciplines and inculcating human values at an individual level. The sociophysics, on the other hand, does involve relatively more external parameters in its dynamics emerging mainly from the constraints of family, society, culture and country. In spite of all this, individual psychology does play a role in building a society and the same is generally accounted for in the studies in a statistical manner (cf. Sect.4.4). As far as the subject of economics is concerned, historically, it has always remained an important utility not only at the family and society level but also at the individual level. It is only in recent centuries, particularly after the scientific advancements and industrial revolutions that the subject of economics is talked about at the national and international levels. The subject of physics, on the other hand, has grown mainly for the understanding of inanimate component in Nature. As mentioned before, its concepts and laws show limitations when applied to living objects. Even then the methodology and tools developed in physical sciences are so noble and elegant that any soft discipline will be enriched by their use.

Recall that the change in Nature is as true as our existence in the universe. This change in general, of course at different scales, might take place with respect to some or all the four variables, namely space, time, circumstances and environment. The subject of physics, in fact, neatly accounts only for the changes with respect to space and time and that too for the closed systems. Whether it is sociology or economics, in either case changes with respect to circumstances and environment dominate the scene as compared to space and time. Hence the source of dynamism in these disciplines is of different type and it does have branch root in individual psychology. In spite of all these changes certain invariants (universalities or eternal truths) can be traced in the studies of these subject, which not only encourage these studies but also help in establishing certain values (human or otherwise) in the world-order.

In view of these considerations economics still remains a subject of immense utility (like food technology, fashion designing, etc.) and that too only for human society and not even for non-human ones. Again, as history reveals, the whims of rulers, political or religious leaders have been playing a dominant roles in its development. Universalities can be traced only in the branch-roots connecting to human element like behavioral economics; otherwise the economics science deals with phenomena which are highly circumstantial and environment-dependent and also spatio-temporal. With regard to the question of economics becoming a part of physical science, note that the two subjects at present, are having beautiful inter-twining analogies of fine (second) order (cf. Fig.1) in spite that their goals and philosophies are different in the process of searching the ultimate reality in Nature.

5.2 Some glimpses of applications of physics tools in economic sciences

There are several branches in mathematical disciplines in physics (cf. Sect. 1.1) which do have roots in pure mathematics or they seem to originate from the same abstract mathematical construct. Also, the tools of applied mathematics, at one time, were found to have maximum applications in physical sciences including chemistry and biology through modeling game (cf. Sect. 1.2). These tools, in fact, are very elegant and at times their applications to a phenomenon forces one to think that they are the God-made or the Nature likes them most in view their predictive power and subsequent experimental verification of results. For example, the roles of power law functions (e.g., linear, quadratic, inverse square laws, etc.), exponential (e.g. simple exponential, $e^{-\alpha x}$, or Gaussian (normal distribution), $e^{-\alpha x^2}$, etc), Fourier transform, second-order ordinary and partial differential equations, random walk theory, group theory, theory of probability etc., are worth recalling in physics studies.

Truly speaking these tools can be applied to any discipline of knowledge through the modeling game, but the fact is that it is the quality of analogy/model (cf. Sect. 1.2) that matters in extracting the knowledge-content pertaining to a given phenomenon in terms of universality or absolute reality in Nature. As human-component is involved at a large scale in both social and economic sciences, the viability of these tools in these disciplines is naturally curtailed. No doubt, these tools can still be effective in some situations but the weakness of the underlying assumptions in modeling the situation further weakens the predictive power of the model and agreements of results with experiments remains only spatio-temporal– far from universality. If at all there appears any universality in the results then it all pertains to the human-element involved in the phenomenon, like human behavior vis-à-vis financial model of a society or behavioral economics, etc. In what follows, we highlight the viability of some mathematical tools and concepts of physics in economic/finance problems.

(a) Use of power laws in economic/finance problems: The asymptotic behavior of probability distribution function f(x) is generally expressed by a power law of a variable x, viz., $f(x) \sim x^{-\alpha}$, where $\alpha>0$ and considered as a fixed constant for a given situation. For example, distinct power laws are used to explain the variance in the growth rate of a company

as a function of company's size, the distribution function for the number of shares in a transaction, the distribution function for the number of trading orders submitted at a specified price from the best price offer, and the size of the price-response to a trade as a function of the size of the company being traded, etc. In particular, an interesting practical application of power laws is noticed in explaining the price movement. In fact, in this case, the power law suggests a scale independence and possible analogies with physics with reference to critical phenomena and non-equilibrium behavior of processes involved which in turn generate financial returns in the market.

Income distribution among high-earning inhabitants in a country is an interesting and hot topic to study economically and politically. The power laws in a scale-free manner have been useful in this regard. In particular, the Pareto distribution (1897), while works in a huge range of income distribution, in the low- and medium –income range, however, its variants (in the form of exponential or log-normal version) are found to work in some countries in view of their varying tax laws.

(b) Role of random walk theory in economic sciences: In 1900 Louis Bachelier, a student of great mathematician Henerie Poincare' , applied random walk theory to study price models in the spirit of Brownian motion. The theory is used to develop extended analytic methods for pricing options or to study as to how the prices behave in the market with reference to demand and supply. In fact, in these studies the size of the price change at time t is correlated to that at time $t+\tau$, even though the directions of price change are uncorrelated. This results into a phenomenon called 'clustered volatility'. Here, while correlations decay as a power law τ^{-r}, with $0 < r < 1$, the price change, however, turns out to be a long-memory process and thus leading to a very slow convergence of statistical averages. Volatility in this case is just one of several long-memory processes and the cause for the clustered volatility can be traced in this process from the varying trend of prices noticed particularly after the entry of both buyers and sellers in the market. Another example of long-memory process is the change in supply and demand which has interesting implications in 'market efficiency'– a fundamental concept in financial economics. In spite of that the coexistence of long-memory supply and demand with market efficiency is not yet understood completely, the former somehow found to be highly predicable in terms of random walk theory. For further details of such studies we refer to the work cited in Doyne Farmer et.al [14].

With a view to understand the correlation between prices of different companies and effect of crashes in the stock market, econophysicists have also employed the methods of random-matrix theory and complex networks [25]. (In particular, a recent version of random walk theory developed basically in modern physics to understand certain microscopic phenomena has been used for this purpose). In another case, the theory of turbulent flow has been used to study the statistics of price movements and to predict the phenomena of clustered volatility in the market. Note that all these studies focus around the use of analogous models and concepts from physics and the gap between the reality and predicted results defines the quality of a model in terms of eqn.(1).

(c) Role of game theory and rational choice in economic sciences: In the finance sector of the market, note that a lot many strategic decisions are taken and naturally by an individual or a collection of individuals termed as 'agents'. The psychology of agents is a crucial factor in controlling the strategic decisions. Here enters the human element in the economic science, particularly in microeconomics. In some sense this debars one to call economics as a science. As a matter of fact, as in games (e.g. in the game of gambling), here too strategies are designed in the light of 'man-made' rational choices (i.e. tax laws) mainly to have more and more wealth. In fact, in the language of economist a rational individual maximizes some measure of personal (usually material) welfare, with perfect knowledge of the world and of other agents' goals and abilities. To this effect, a study of behavior of agents also becomes a necessity which also is a type of modeling but at a higher level with a view to having sustainable and smooth going economic policies in a country.

Making policies in view of the economic thinking about individual choices constitutes the subject of micro-economics and the same is dominated by the assumption that decisions of real human Beings can be approximated by rational choice. As far as the use of these rational decisions in real financial market is concerned, they at times they miserably fail. Also, these theoretical approaches somehow do not solve the problems of macro-economics completely, like the aggregation of individual choices and the behavior of large populations, etc.

With a view to capture the essence of collective behavior in a finance market, an alternative to rational choice in the form of minority game is also followed by econophysicists. The game is designed so that only a small number of persons are beneficiary (e.g., the group of corporators, industrialists or politicians, etc.). In this case the experienced agents are capable of remembering certain number (M) of prior rounds of play and also maintain an inventory of strategies (the so-called 'look up tables') that dictate a next move to each history. No doubt, these look-up tables are generated at random but the strategy used there in corresponds to the best cumulative performance. For the case when the agents have at least two strategies, the minority game offers phase transitions in the ratio $z = 2^M / N$, where N is the number of agents involved and the numerator defines the number of resolvable pasts in the number of agents.

(d) Use of entropy methods in economic sciences: The concept of entropy developed basically in thermodynamics, has now offered a methodology to understand the phenomenon of turbulence or disorder in a variety of disciplines in physics and other mathematical sciences, particularly to study the irreversible or nonequilibrium processes in the context of open systems. In economics, financial markets offer an example of open systems. In fact, the markets considered here only as conduits for goods produced or consumed elsewhere, are described by theories of partial equilibriums which are characterized by the open-system boundary conditions. Economists, in this case, try to determine general equilibrium of whole society, by way of accounting for the trade and production, consumption and for the government laws as well. As in physics, here too the principle of entropy-maximization works in the form of maximum-ignorance principle and the same in fact has been found

useful for discussing the conceptual foundations in economics. For more details of application of this method we refer to the work of Smith [27].

5.3 Some remarks on behavioral economics

From the survey in the previous section it appears that physics will continue to contribute to economics in a big way in solving the problems ranging from macro-economics to market-micro structure. This in turn will also have implications in economic policy making, where arises the role of human component or behavioral economics, and generally accounted through statistical analyses [27].

Behavioral economics basically is the study of (human) psychology with reference to the economic-decision-making processes of individuals and institutions. Even in this case note that there are two distinct and important situations, namely the cases of short-memory and long-memory processes. In this connection two questions are normally addressed, namely (i) are economists assumptions of utility or profit maximization good approximations of real people's behavior? (ii) Do individuals maximize subjective expected utility? Several notable economists have contributed to the answer of these questions and have accordingly been honored with Nobel memorial prizes in the recent past. For example, Herbert Simon (honored in 1978) explored the concept of bounded rationality or studied the decision making processes in economic organizations; Gary Becker (honored in 1992) looked into the problem of people's motive and consumer market problems and George Akerlof (honored in 2001) studied the market-behavior with 'asymmetric information'. Daniel Kahneman has been honored in 2002 for his research on prospect theory, in particular, for exploring the concepts of 'illusion of validity' and 'anchoring bias'. The prospect theory basically deals with human judgment and decision making processes under uncertainty. Recall that economics, historically, has assumed that people act in their self-interest and make rational decisions. Kahneman's research combines psychology with economics to explore as to how people's behavior may depart from these classical assumptions. In the next section we shall revisit the essence of Kahneman theory in the light of patomic model and suggest some possible modifications in it with a view to having a better human judgement and a fine-tuning of decision making processes.

5.4 Revisiting the Kahneman theory in the light of Vedic wisdom

5.4.1 Short- and long-memory processes and the two selves of Kahneman

In some sense the short-memory and long-memory processes appearing in the market strategies are the outcome of short-term and long-term thinking built in the psychology and behavior patterns of an individual or a society as a whole. This fact is beautifully exploited by Daniel Kahneman in developing his prospect theory in behavioral economics, particularly in his recent best selling book "Thinking, Fast and Slow" [29]. In day-to-day life we call these processes as 'immediate' and 'second thought' reactions towards an event in the outer world. He, in fact, introduces the characters of a hypothetical story as 'system 1' and 'system 2'. A close observation of the development of the subject matter in the introduction of the book clearly reveals that these two systems of Kahneman basically are two components of the

micro-body $\mathcal{M}$ (cf, Sect.3.1(b)), denoted here as gross part $\mathcal{M}_g$, and sub-conscious part $\mathcal{M}_s$, respectively. The same will be elaborated in the next section.

According to Kahneman, the system 1 operates automatically and quickly, with little or no effort and no sense of voluntary control. On the other hand, the system 2 allocates attention to the effortful mental activities that demand it, including complex analysis and computations. The operations of the system 2 are often associated with the subjective experience of agency, choice and concentration. A kind of psychodrama of system 1 and system 2 is described in the entire book at a very fine level which finally ends up with the birth of a new economic science in terms of experience and decision utilities and a subject like intuitive statistics. What a great job Kahneman has done by bringing the subjective science of the Self to the level of most practical modern science of economics however without really going in to the details of patomic model and the associated dynamics of EOLs. Next, we demonstrate the connection between the Kahneman theory and the more generalized concepts discussed [5] in the patomic model of human Being.

5.4.2 The two selves of Kahneman in patomic model and their psychodrama

With a view to identifying the system 1 and system 2 of Kahneman in the patomic model of human Being (cf. Sect.3.1), the constituent of the micro-body M can be reconstructed [2] as shown in Fig.4. For this purpose, note that each member of the trio, mind, intellect and ego is considered as consisting of a gross part and a sub-conscious part. The gross parts of all three combine again to give the gross part of $\mathcal{M}$ (denoted as $\mathcal{M}_g$) and the combination of sub-conscious parts of them gives the sub-conscious part of $\mathcal{M}$ (denoted as $\mathcal{M}_s$). Note that these $\mathcal{M}_g$ and $\mathcal{M}_s$ are the system 1 and system 2 of Kahneman, respectively which latter are also termed as 'experiencing self' and 'remembering self', by Kahneman on the basis of their functions. Further remarks on the work of Kahneman are as follows:

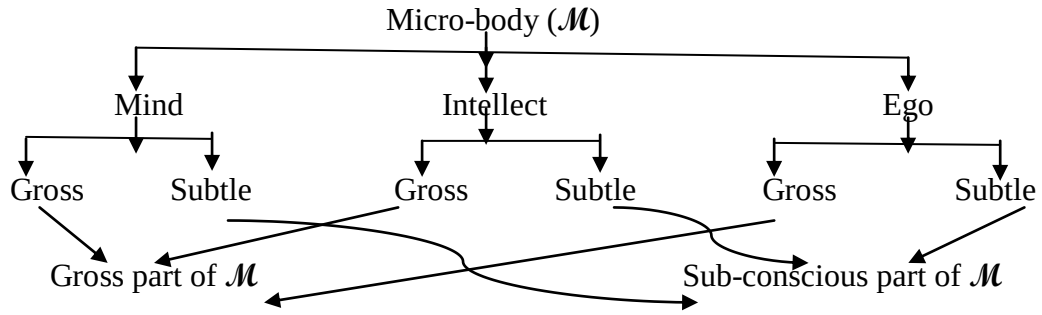

Fig.4: *Schematic display of as how the micro-body M of patomic model splits into the gross part $\mathcal{M}_g$ and the sub-conscious part $\mathcal{M}_s$.*

(i) An important outcome of the theory of Kahneman is the frequent demonstration of the connection between the time and the meditation variables in the book. From his work it appears that the thinking process is 'fast' with reference to system 1 and it is 'slow' with reference to system 2 and all this is with respect to the (physical) time variable. However, as per our common experience, the meditation takes us in reverse order, i.e.,

first it overcomes the constituents of the set $\mathcal{G}$, namely WO, B, SE and then enters into the realm of $\mathcal{M}$, namely M, I, E and finally into the realm of $\mathcal{C}$ (cf. Fig. 4). On the other hand, the gross component $\mathcal{M}_g$ (system 1 of Kahneman) of M is operative in conjunction with $\mathcal{G}$. Thus, the meditation (variable μ) has inverse/reciprocal dependence on time t as analyzed elsewhere (c.f. Ref.(1), Chapter 1). Note that the intensity of thinking would depend on the internal variable μ, whereas the 'slowness' or fastness' of thinking depends on the external variable t but only in the $\mathcal{G}$ and perhaps in the $\mathcal{M}_g$ domains. In fact, in order to account for the efficiency of systems 1 and 2 or for the intensity of thinking process, one should also consider the evolution of these systems with consciousness. Some glimpses of discrete evolution are given in the next sub-section.

(ii) The way in which the thinking process is considered and analyzed by Kahneman through the drama of system 1 and system 2, clearly shows that it is a complex process, i.e., it is not just the act of the inner EOL I in the present context but that of a collective entity to which the contribution does come from other inner EOLs, namely from M and E. Kahneman, however, seems to attach only the memory aspect to it by calling system 2 as "remembering self". As a matter of fact there are several other aspects of exchanges considered between the system 1 and the system 2 which would require the thinking to be a composite process in the present scheme of study.

(iii) In Kahneman's work the set of systems 1 and 2 is studied in isolation. But in reality it is not so, for both are active only in the presence of consciousness that originates from the entity SO. Also, $\mathcal{M}_s$ is linked with $\mathcal{C}$ on the one end and the component $\mathcal{M}_g$ is linked with $\mathcal{G}$ on the other. Kahneman, no doubt, accounts for the linkage of $\mathcal{M}_g$ with $\mathcal{G}$ (i.e., with the outer world) but ignores the linkage with $\mathcal{C}$ completely. As a matter of fact, the consideration of this latter linkage in the theory would definitely bring the spirituality content in the output (i.e., in the behavior and character of an individual) in the same way as the consideration of the former linkage has provided a better reason for the worldly-living in economic terms.

5.4.3 Efficiency of the two selves of Kahneman: Possible modifications in the theory

According to the theory of Kahneman the two selves, namely 'experiencing self' and 'remembering self' (which, in fact, in the present scheme of study are the gross component $\mathcal{M}_g$ and sub-conscious component $\mathcal{M}_s$, respectively) work at different time scales or in different spatiotemporal zones and so do their actions are defined as 'fast' and 'slow'. But the fact is that their working lies in different meditation zones or at different levels of attention. (Basically, attention is a directed, channelized or focused version of consciousness that provides the cognizance of working of one-self to the other or vice versa). Further note that the efforts of an individual are associated with $\mathcal{M}_s$ and his actions mostly with $\mathcal{M}_g$. Moreover, when one talks of the quantification of the efficiency of $\mathcal{M}_s$ and $\mathcal{M}_g$, one need to understand their ability and limitations in terms of their evolution with consciousness and/or with spatio-temporal circumstances.

As mentioned before, there are two ways to analyze the process of perception of an external stimulus in a given environment. In one case, one proceeds with the dynamics of EOLs and accounts for the environment/circumstances separately, preferably by introducing a parameter for it from outside. In other case, one considers the successive evolutions of EOLs with consciousness either by way of their successive dressing with consciousness (discrete evolution) or by writing a differential equation for the evolution of the constructed mindset function (continuous evolution). These evolutions of EOLs with consciousness will, in turn, enrich the EOLs with knowledge about the stimuli (see, Ref. (5), Chapter 8). Note that $\mathcal{M}_g$ and $\mathcal{M}_s$, which are basically certain combinations of inner EOLs, namely M, I and E, will also undergo some sort of dressing with consciousness, particularly when one wishes to account for the interplay or the psychodrama between them in view of the external environment. In what follows, we identify the dressed versions of $\mathcal{M}_g$ and $\mathcal{M}_s$ in view of their definitions given above and use the discrete dressing rule (*tri-karan* rule) defined through Eqs. (2a)-(2c). For this purpose, we write the n-th order dressed version of the micro-body $\mathcal{M}$ as $\tilde{M}^{(n)} = \left\{\tilde{M}_g^{(n)}, \tilde{M}_s^{(n)}\right\}$ with corresponding gross and subtle components as $\tilde{M}_g^{(n)} = \left\{\tilde{M}_g^{(n)}, \tilde{I}_g^{(n)}, \tilde{E}_g^{(n)}\right\}$, $\tilde{M}_s^{(n)} = \left\{\tilde{M}_s^{(n)}, \tilde{I}_s^{(n)}, \tilde{E}_s^{(n)}\right\}$. Here, $\tilde{M}_j^{(n)}, \tilde{I}_j^{(n)}, \tilde{E}_j^{(n)}$, $(j = g, s)$, In terms of their (n-1)-th order dressings, are given by

$$\tilde{M}_j^{(n)} = \frac{1}{2}\tilde{M}_j^{(n-1)} + \frac{1}{4}\tilde{I}_j^{(n-1)} + \frac{1}{4}\tilde{E}_j^{(n-1)} \quad , \tag{5}$$

$$\tilde{I}_j^{(n)} = \frac{1}{2}\tilde{I}_j^{(n-1)} + \frac{1}{4}\tilde{E}_j^{(n-1)} + \frac{1}{4}\tilde{M}_j^{(n-1)}, \tag{6}$$

$$\tilde{E}_j^{(n)} = \frac{1}{2}\tilde{E}_j^{(n-1)} + \frac{1}{4}\tilde{M}_j^{(n-1)} + \frac{1}{4}\tilde{I}_j^{(n-1)} \; . \tag{7}$$

In view of the above mathematical constructs, the following remarks are in order:

(i) The orders of dressing of $\mathcal{M}_g$ and $\mathcal{M}_s$, say *n* and *l* in $\tilde{M}_g^{(n)}$ *and* $M_s^{(l)}$ in some sense, will define their efficiency of working.

(ii) When one talks of exchanges (or psychodrama) between $\mathcal{M}_g$ and $\mathcal{M}_s$ the orders of their dressing with consciousness will matter and constitute a matrix $\tilde{M}_g^{(n)} \times \tilde{M}_s^{(l)}$ which, in turn, might offer explanations of a variety of situations discussed by Kahneman in his book.

(iii) An abstraction of the dressing rule associated with the relations (5) – (7) in the form,

$$\mathrm{I_j}^{(n+1)} = \sum_k a_{jk}\ \mathrm{I_j}^{(n)} \quad , \tag{8}$$

can also offer explanations of some other additional aspects of the psychodrama between $\mathcal{M}_g$ and $\mathcal{M}_s$, particularly by studying the properties of the matrix a_{jk} . Here a_{jk} for j,k = 1,2,3 constitute a matrix with $\sum_k a_{jk} = 1$ for given j, and $\mathrm{I_j}$ = M, I, E, for j = 1,2,3, respectively.

All the above remarks, however, require further discussion and deeper studies.

CHAPTER 6
CONCLUDING DISCUSSION

Note that it is human component in general and the individual human Being in particular that plays a dominant role in all studies in humanities and social sciences including sociology and economics. As far as the understanding of the human Being and his actions in the outer world is concerned, the subjects of anthropology and psychology in conjunction with philosophy have been explored to a considerable extent in recent times. Still the success in these endeavors remains limited in the Western way of the thinking, perhaps, this is due to the lack of identifications of fundamental essences of life responsible for the existence and survival of a person in this world. In this respect, no doubt, Eastern (Vedic) thinking has gone little deeper and the same has been exploited here to explore new and additional dimensions of study of modern sociology and economics.

It is not that we are searching a base of modern developments in soft disciplines in the ancient Indian wisdom here for the first time, rather there have been several attempts in the past when the foundations of modern physics were sought in ancient Indian and Greek wisdom (see, e.g. the works of Misner and Wheeler [30], Schrodinger {31], and Harrison [32]). Note that in these works the reference to Indian wisdom was made only tangentially but the fact is that the latter is a treasure of a lot many original ideas. Note that in most of these works analogies of certain order between the two approaches were pointed out with a certain degree of justification. Here, however, we have tried not only to revive the subject of psychophysics with its still deeper foundations within the framework of Vedic science but also shown its viability to offer a unifying scheme to study sociophysics and econophysics. For this purpose, first a new dimension of study of psychophysics in terms of a philosophical atom like (patomic) model of human Being is suggested. As far as the interactions between and among the human Beings, between human Being and physical world (stimuli) are concerned they are beautifully accounted for through such a picture at the most fundamental level and more in analogy with physical theories [5]. Further note that a reduced version of the patomic model in terms of gross ($\mathcal{G}$), micro ($\mathcal{M}$) and causal ($\mathcal{C}$) bodies is found convenient for many of these studies at least in the lowest-order.

In fact, in the absence of availability of any formal theory at present for properly accounting for the human component (consciousness) in both soft (humanities) and hard (physical sciences) disciplines, such a simple model of human Being, based on the ancient Vedic wisdom, can prove to be an asset. It is emphasized that before using the concepts and theories of physics in any discipline of knowledge, it is necessary to understand their domain of working and the ensuing limitations.

It is true that such interdisciplinary studies, most of the time, are carried out using analogies and analogous models. As far as the understanding of the ultimate reality (whether subjective or objective, depending upon the phenomenon under study) in Nature through such tools is concerned, it again depends on the quality and nature of analogy (cf. Sect. 1.2) used for this purpose. In order to judge these features in the use of an analogy at a subtle level, a generalized concept of structural analogy is also highlighted here. The patomic model itself

offers one such a fine example in this case, of course at a more subtle level than atomic model of matter. Moreover an analogy can never be a reality, it only hints towards the reality even if there is a support from human/instrument-based observations. The ultimate reality remains a matter of realization only, which in principle is possible for all of us according to the development of our own faculty of understanding. In fact, the quality of knowledge thus acquired through these studies of interdisciplinary subjects like sociophysics and econophysics cannot be underestimated, particularly when one talks of universality, sustainability or invariants in social dynamics or in the changes in financial markets. Among several analogies studied in this context, the use of ideal gas model to understand the kinetic exchange of wealth could be an interesting case. Basically, these aspects of study are the outcome of human interactions with other humans and with the physical world. Note that the analogous use of mathematical constructs may be good enough in data-fitting or for some limited studies and the same can be exploited to any extent in existing studies but do not necessarily suffice when the question of drawing better insights about the subject from such studies are concerned. The psychophysics in its new incarnation can perhaps contribute a lot in such fundamental studies.

Another important ingredient and the factor that matters in the study of interdisciplinary subjects like sociophysics and econophysics is the concept of complexity involved in the given system. In fact the plurality of scales at which the 'cause and effect' principle is understandable in the functioning of a system through its sub-systems, is a measure of degree of complexity. These scales are highly restricted in the case of 'pure' physical systems, particularly when they are considered as closed systems. Cause and effect principle(s) in the domain of physics are purely the space-time mediated one. For an epiphysical system (the physical system that is exposed to one's consciousness as is the case in quantum measurement) or a special epiphysical system (the physical system that also contains the source of consciousness in addition to the exposition by it, like the biological body of an alive person or any organ for that matter), however, these space-time mediated cause and effect principles of physics do not suffice and the hierarchy of new class of cause and effect principles, which are defined in a domain beyond space and time come into existence. It is this new hierarchy that appears in a social system or in the studies in economics through 'human component'. Now the question is as to how to account for this new hierarchy in socio-physical or in econo-physical studies. Use of the suggested patomic model of human Being through the subject of psychophysics in its new incarnation definitely offers one such and a new dimension of study in all the subjects involving human component, then what to say of sociophysics or econophysics. Political science, human geography, environmental science, evolutionary biology, besides behavioral economics and social psychology are some other areas where this newly emerged psychophysics can find meaningful applications.

It may be mentioned that while physics mostly deals with the spatiotemporal Cartesian grid and thereby the space-time mediated interactions through contact and action-at-a-distance type forces, the appearance of human component in these interdisciplinary subjects would require an entry into the domain beyond space- time and an account of action-at-a-time type forces. These features in socio- /econo-physics, in fact, are already appearing through the

studies of short-memory or long-memory processes or through the 'thinking, fast and slow'. It is not that the physics laws and concepts are used only to glorify the soft disciplines with a view to explore them better but the studies in reverse order can also be meaningful. In fact, some intricate phenomena in sociology and economics, though appearing in the presence of human component, can also inspire physics to carry out a fine-tuning of physical laws or they are capable to provide tools for alternative studies in physics theories. This would require an account of a variety of nonlinearities in the equations and that too in higher dimensions. The same was tactfully avoided in the development of physical laws and theories in the last century, perhaps due to the non-availability of sufficient mathematical or computational tools for this purpose in those days. But now the situation has changed and such exact analytical results are desirable, particularly in psychology and economics. Among new tools, the use of graph theory, and complex network analysis have proven an asset in these studies in recent times.

With regard to the personalities of agents in financial market or of consumer members in a society, particularly in the context of Kahneman theory, Vedic wisdom does offer [7] several new and viable alternatives in studies in terms of three Nature-born *gunas*, namely *satvik*, *rajasik* and *tamasik*. This will further fine-tune the dynamics of two selves of Kahneman through $\mathcal{M}_{\mathrm{g}}$, $\mathcal{M}_{\mathrm{s}}$ and the matrix (a_{jk}) (cf. eqn (8)) . Such studies are worth pursuing in behavioral economics.

As far as the use of physics laws and physical theories in sociology and economics is concerned, the nature and quality of approximations or analogies in this case is definitely one order higher than that in individual psychology. The reason is the presence of the role of many-human Being-interactions in the phenomenon. While the study of three- and higher-body forces in physics already poses a problem even today, the understanding of three and higher- human Being- interaction poses the bigger problem [2] in several respects. In this regard the use of psychophysics in its new incarnation appears to involve fewer approximations and expected to offer better asymptotic approach to absolute reality.

From psychophysics to psychochemistry and the emergence of sociochemistry and econochemstry: In the same way as the knowledge of individual atom led to the development of the subject of chemistry with reference to the interactions/reactions between two and more atoms/molecules, the patomic model of Sect. 3, also offers a similar situation. Note that patomic model does offer very fine parameters [7] to distinguish between different personalities in terms of dressing of EOLs with consciousness and/or a hierarchy of interactions and scales through $\mathcal{G}$, $\mathcal{M}$ and $\mathcal{C}$. Alternatively, one can as well start with the level of development of one's FOU and accordingly develop the subject of psychochemistry. While further details need to be investigated, some preliminaries to this effect, have already been carried out (see, Ref. (2), Chapter 12). Once such a psychochemistry becomes available, this will naturally open new dimensions of study of the subjects of sociochemistry and econochemistry with reference to the amalgamation/interaction of two and more societies, cultures or economies in modern times.

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